

# Kenya's Water Towers; A Scenario Scrutiny of Njoro Sub Catchment, Eastern Mau Towers

<sup>1</sup>Ontumbi George Morara <sup>2</sup>Sanga Jaco Kiptoo

<sup>1</sup>(B. Ed., Msc. Ph. d on going) Senior Lecturer Ollessos Technical Training Institute

<sup>2</sup>University of Eldoret

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# Kenya's Water Towers; A Scenario Scrutiny of Njoro Sub Catchment, Eastern Mau Towers

<sup>1</sup>Ontumbi George Morara <sup>2</sup> Sanga Jaco Kiptoo

<sup>1</sup>(B.ed, Msc Phd on going) Senior Lecturer Ollessos Technical Training Institute

<sup>2</sup>University of Eldoret

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## Abstract

The continent of Africa is endowed with natural capital and its sustainable development is dependent on the capacity to efficiently and sustainably manage the natural resources especially water, land and forests for the benefit of its population. A mountain forest plays an irreplaceable role in water catchment, in the retention and release of water in the hydrological cycle. The highland itself causes clouds to form, which drop their moisture in the form of rain or mist. A mountain forest with its numerous plant species absorbs and retains far more water than farmland or any other form of vegetation. Natural ecosystems such as forests, wetlands,

rivers and lakes provide a wide range of goods and services to society including food, water, energy and recreation and can therefore they should be considered as life insurance assets. Mau water catchment is a fragile ecosystem whose dynamics have been subjected to human interferences. The purpose of this study was to determine the cover changes within the Njoro catchment from 1986 to 2016 and thereafter propose necessary strategies and mitigations to prioritize interventions to check on further degradation. Desk top literature and Landsat images of 1986, 2006 and 2016 were used to analyse and determine the extent of changes in forest cover over the period of 30 years. The results obtained from the Landsat images showed the area under forest in 1995 was approximately 10,383 Ha which reduced over time to 6,653 Ha in 2016. In conclusion, the variability in forest cover is thought to be dependent on other catchment factors like soil type, slope and climate variability consequently therefore there is need to evaluate and manage land cover and land use changes for sustainable development of Njoro sub catchment of Mau towers.

## 1.0 Background to the Study

Over the past decade and a half there has been a quantum shift in attitudes and understanding in Kenya about upland forests, their value, and how to protect them to ensure sustainability of the country's rivers. The concern of the conservation of Kenya's rivers has resulted to the phrase 'water towers' which has been coined and accepted in water catchment and environmental conservatism. A mountain forest plays an irreplaceable role in water catchment, retention and release (Ministry of forest and wildlife, 2013). The highland itself causes clouds to form, which drop their moisture in the form of rain or mist. A mountain forest with its numerous plant species absorbs and retains far more water than farmland or any other form of vegetation. The roots of the trees provide channels

down which the water flows, deep into the ground. The soil there becomes a reservoir that sucks up water and then releases it slowly into the water table, streams and rivers, ensuring a steady flow throughout the year.

Destroy the forest and rain water will pour off in flash floods, causing erosion, destroying the topsoil, triggering landslides, and playing havoc with agriculture. But upland forests in Kenya have been under severe and sustained threat for years, losing some 5,000 hectares of tree cover a year. Now finally it has become apparent that unless drastic action is taken, what will be lost is not just trees but animals and biodiversity. Collectively highland forests cover about 2% of Kenya's land surface, but their value to the country's environmental stability, economic development and human well-being is, literally,

priceless. Since the late 2000s, forest conservation has become instrumental in the achievement of new ambitious national objectives in terms of environmental protection in Kenya (GOK, 2010). The formulation of environmental protection objectives has been greatly influenced by the international agenda on climate change adaptation and mitigation. Charline (2011) observes that the conservation of the national water resources can also be regarded as one of the main driver of public action in the forested areas of the country. In the last decade, the concept of “water tower” has been widely disseminated and accepted in Kenya. Though many features of this concept still need to be specified (especially regarding its territorial extent), it has become an efficient means of justification for public intervention in some of the “degraded” national forests, allowing in some cases the (controversial) eviction of population living in forest reserves.

Population pressures, the lack of planning and the commensurate increase in the demand for resources have placed undue pressure in our Water Towers. Environmental degradation and more precisely deforestation have become a common phenomenon in rural landscape throughout the African continent. Between the years 1990 and 2010 Kenya lost 2.8% of its forest cover. Forest cover is closely related to water conservation, this ecological phenomenon becomes clearer when forest cover is removed and its subsequent impacts on river flow. However the Kenya Forest Service has put a lot of effort towards achieving a 10% forest cover as proposed in the Kenyan Constitution and Kenya’s Vision 2030. The Mau Forest Complex is the largest closed-canopy montane ecosystem in Eastern Africa. However, in the recent past, the Mau Forest Complex has undergone significant land use changes due to increased human population demanding land for settlement and subsistence agriculture (Charline, 2011). The encroachment has led to drastic and considerable land fragmentation, deforestation of the headwater catchments and destruction of wetlands previously existing within the fertile upstream parts. Today, the effects of the anthropogenic activities are slowly taking toll as is evident from the diminishing river discharges during periods of low flows, and deterioration of river water qualities through pollution from point and non-point sources (Baldyga *et al.*, 2007).

## 1.2 Statement of the problem

In Kenya, the various catchments and water towers have been increasingly characterized by human settlement, deforestation, wetland reclamation and unsustainable agricultural activities as observed by UNEP, (2006) and Aura *et al.*, (2011). There are various challenges posed by ever increasing anthropogenic activities in the river catchment areas ranging from destruction of the riparian vegetation and catchment areas to agricultural activities, urbanization and municipal waste. The rapid dynamics in land use/cover occasioned by clearing of the forested land for agricultural production and settlement in the river catchments areas are adversely affecting the hydrologic characteristics of the major rivers in Kenya. The human activities near stream and water catchment areas have been reported to cause the degradation on stream habitat and hydrological characteristics in Kenya. Destruction of the riparian zones in the river catchments has rendered the protective nature of the catchment areas ineffective or even detrimental to the water towers in Kenya. With the tremendous growing population and multiple activities in the river catchments, the catchments have been rendered environmentally unstable. Therefore these unabated activities in the water towers necessitate the interrogation of past studies and surveys on the scenario and the degradation levels.

## 1.3 Study Objectives

- i. To assess the land use /land cover modifications in the Njoro River catchment between 1996 and 2016.
- ii. Propose necessary information to prioritize interventions towards addressing further degradation of the Njoro catchment.

## 1.4 Scope

Njoro sub catchment is located in Eastern Mau is in the Rift Valley Province of Kenya and lies between Njoro plains and the upper slopes of the Mau hills. The area is drained mainly by rivers Njoro and Lamriak which originate from Eastern Mau escarpment and empty into Lake Nakuru. This study targeted desktop literature review on scenario scrutiny of the Mau forest water tower and remotely sensed data of the Njoro sub catchment and focused on the various human activities and land cover contributing to the deterioration of the water catchments with emphasis to: deforestation, agriculture, rural and urban settlements as main land use activities.

### 1.5 Justification

The water scarcity and consequently water crisis in Kenya can be attributed to the degradation of the water towers. This study would form the broad framework aimed at sustainable development and proper management of the catchments and the River basins in Kenya with the emphasis on environmental conservation as demonstrated by the establishment of National Environmental Action Plan and National Environmental Management Authority (NEMA). The sustainability in development will consequently enhance proper long term management of the Kenya's River catchments and seek to provide solutions to the problems of the water scarcity in Kenya. The findings from this study will guide the authorities in environment management on the venerable areas within the water towers and therefore create awareness among the inhabitants on the effects of the various activities on water resources and therefore become useful for decision making and policy interventions with regard to water resource management.

## 2.0 Literature Review

### 2.1 Mau Forest Complex

Deforestation of montane woodlands in Kenya threatens Kenyan social, agricultural systems and the native ecosystems as observed by Maathai (2010). Indigenous plant loss reduces forest ecosystems' capacities for rainwater conservation, eroding valuable topsoil and desiccating rivers. Detriments to agriculture are exacerbated by the clear-cutting of forests and establishment of exotic tree monocultures for commercial timber production. The Kenyan shamba system, an arrangement allowing local farmers to grow crops while tending to exotic tree saplings on commercial or state-owned land, has long been supported as a solution to deforestation and an aid to subsistence agriculturalists. Yet closer examination reveals that the shamba system has endangered the indigenous forests in Kenya by alienating local interests from those of the environment, thereby promoting environmental degradation. Although dependence upon native plant species for food and medicine once aligned the interests of indigenous farmers with those of forest ecosystems, imposition of the shamba system upset traditional customs of land appropriation, alienating Kenyans from the land on which they relied. The system opposes the practices by which indigenous populations sustain themselves and practices that support forest preservation, as it incentivizes farmers

to clear native vegetation and to actively hinder the growth of plantation saplings.

The Mau Forest Complex (MFC) is one of the important sources of water in the Rift Valley and the Western parts of Kenya. The Mau Forest Complex forms the upper catchments of majority of the main Kenyan rivers west of the Rift Valley. MFC is one of the most important sources of water in Kenya providing water for multiple uses to millions of people in both Rift Valley and Lake Victoria drainage basins (UNEP/GOK, 2008). The Mau Forest Complex is dissected by numerous rivers, river tributaries, and streams which form at least a part of the twelve main rivers whose sources are found within this forest complex and flow into three of Kenya's six main drainage basins, the Rift Valley, Lake Victoria North, and Lake Victoria South.

The Mau Complex is the largest remaining closed canopy forest block in Eastern Africa covering an area of about 400,000 ha. It forms the upper catchments of all, but one, rivers that drain west of the Rift Valley, including Nzoia, Yala, Nyando, Sondu and Mara, which drain into Lake Victoria. It is also the main catchment of critical lakes and wetlands in the Rift Valley, including lakes Baringo, Nakuru, Naivasha, Natron and Turkana. The forests of the Mau Complex are also very rich in flora and fauna. The Mau Forest Complex is one of the five water towers in Kenya, providing the upper catchments of many major rivers, including Nzoia, Yala, Nyando, Sondu, Mara, Kerio, Molo, Ewaso Ngiro, Njoro, Nderit, Makalia, and Naishi (Republic of Kenya, 2009). These rivers in turn feed major lakes, including Natron, Victoria, Turkana, Baringo and Nakuru

Human-induced disturbances due to land use activities have the greatest potential for introducing enduring changes to the ecological structure and functions of watersheds. Over the years, degradation of water resources within the River Njoro watershed has occurred due to a number of factors. High population growth rate and the associated change in land use have placed high demands on the watershed resources, thereby upsetting environmental stability as observed by Shivoga *et al.*, (2005). This has impacted negatively on the ecological integrity and hydrologic processes in the River Njoro watershed (Mathooko, 2001). The sprawl patterns of human settlements and land use change have been implicated as the primary causes of deteriorating health of the River Njoro watershed. Land cover classification using Landsat images (Baldyga *et al.*, 2004) showed loss of about

20% in both indigenous and plantation forest between 1986 and 2003 in the upper River Njoro Watershed.

## **2.2 Importance of Water Towers**

At a time when the world is confronted by climate change, forest cover can help to mitigate the effects of droughts and floods. Forests trap, store and slowly release rain water, the life blood of the economy. They support agriculture, fisheries, electricity production and urban and industrial development. Forests also produce wood and medicines, moderate climate, reduce erosion, shelter a disproportionate share of Kenya's biodiversity, and have religious and cultural significance (GoK, 2013). The water towers in Kenya form the upper catchments of all the main rivers. The "water towers" provide water to all installed hydro-power plants, producing some 70 percent of Kenya's electricity output. These montane forests are also surrounded by the most densely populated areas of Kenya, because they provide enough water for intensive agriculture and urban settlements.

## **3.0 Materials and methods**

### **3.1 Land use and land cover changes analysis**

Satellite images were analysed in conjunction with ground truthing observations as proposed by Chakraborty & Chandrasekharan (2001). Using a Global Positioning System (GPS), points corresponding to the various land uses and land cover forms were recorded as forest, agriculture, grassland, settlement and commercial. Remotely sensed data and ground survey methods were used to evaluate the land cover /land use change in the study area. A combination of fine, medium and coarse resolution images from different platforms were used to detect changes. Land use and land cover maps were developed from the satellite images through defining

spectral classes by clustering image data and assigning pixels into classes.

## **3.2 interventions towards addressing further degradation of the Njoro catchment**

This study targeted desktop literature review and recommendations of the earlier researches on the larger Mau forest catchment. The analysis will focus on the various human activities and land cover contributing to the deterioration of the water catchments.

## **4.0 Results Scenario Analysis**

### **4.1 Impacts of Land use cover change**

The use of remotely sensed data showed that river Njoro catchment has had a significant change in land use cover over the last 20 years. The results of the lands at image and analysis are presented in figures 1, 2 3 and table 1. The results of the land sat images analysis depicted an increase in the area under agricultural activities, residential and commercial settlement while there was gradual decrease in the area under forests and shrub land. This scenario is well demonstrated in deforestation, land fragmentation, cultivation of wetlands and rapid increase in human settlements. As land use changes from forest to rural built-up lands, urban lands and subsistence agriculture, surface runoff increases while surface and groundwater quantity will reduce. The effect is manifested in reduced natural recharge, reduced stream flow and elimination of wet lands. Currently, there is a steady recognition that surface and groundwater sources are declining. River Njoro no longer flows throughout the year. Boreholes are drying up. Consequently there is a like hood of a reduction in the water quantity in Lake Nakuru would be blamed on deforestation in the Mau range which is the source of rivers Njoro.

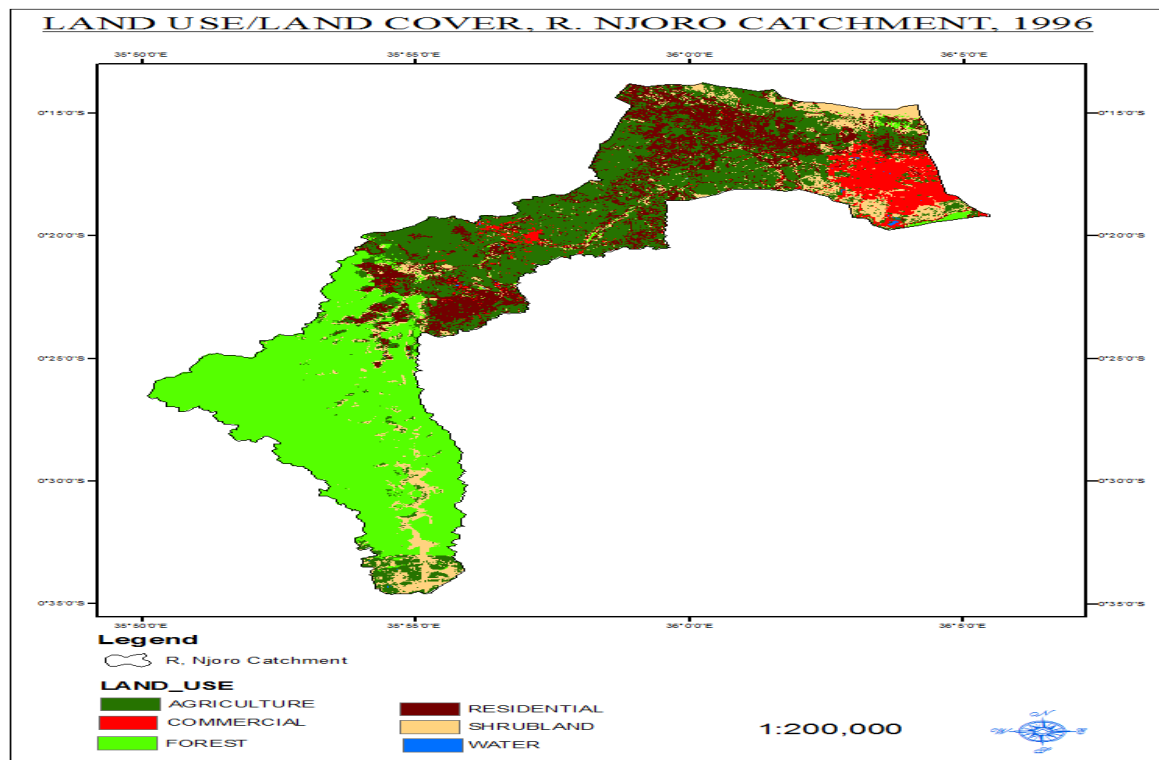


Figure 1: Land use/land cover of River Njoro catchment in 1996 (Author)



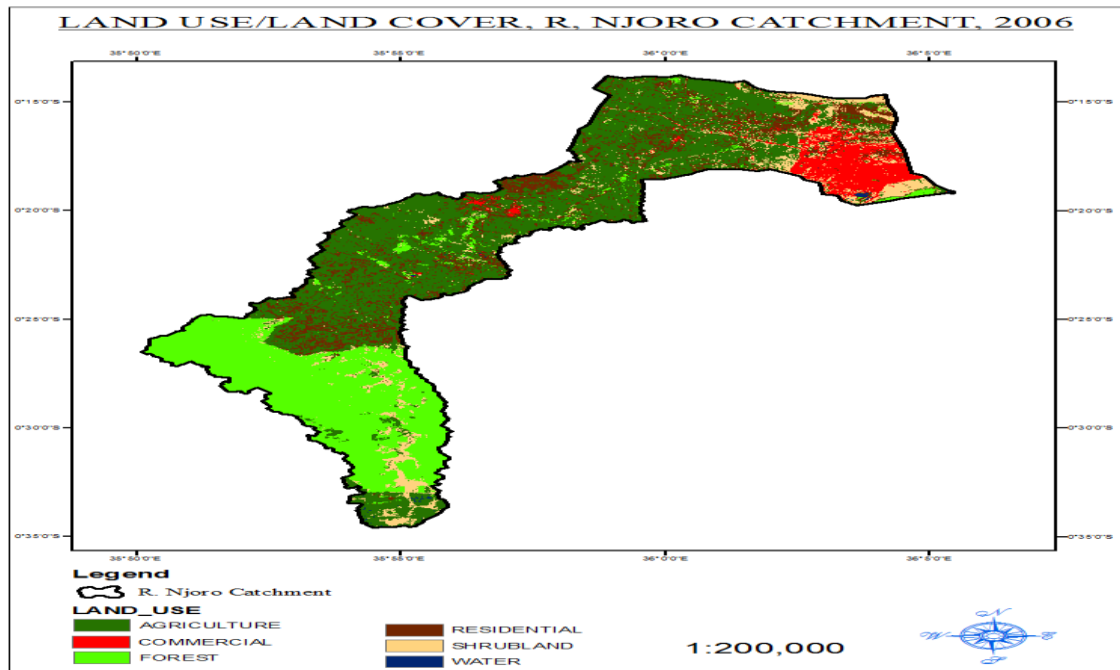


Figure 2: Land use/land cover of River Njoro catchment in 2006 (Author)

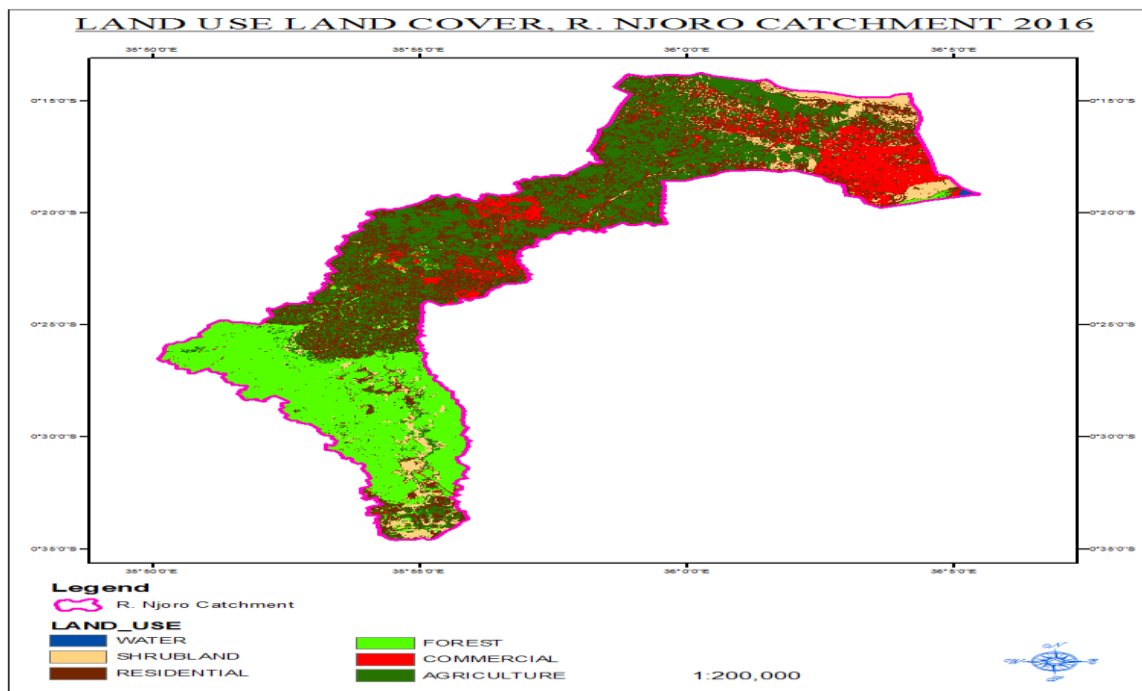


Figure 3: Land use/land cover of River Njoro catchment in 2016 (Author)

**Table 1: LAND USE/LAND COVER CHANGES IN THE RIVER NJORO CATCHMENT**

LAND USE/COVER CLASSES	1995	2008	2016
FOREST	10158.04	9686.41	7052.85
AGRICULTURE	8595.43	9005.23	8660.17
RESIDENTIAL	3136.1	3460.05	5771.55
COMMERCIAL	1545.21	1618.65	2673.57
SHRUBLAND	2492.33	2129.04	1771.46
WATER	1026.27	1054	1023.78
TOTAL	26953.38	26953.38	26953.38



**Plate 1; Charcoal burning**



**Plate 2; Encroachment into the forested area**



### **Interventions to water catchment degradation**

The Kenya Government should develop guidelines to integrate environmental concerns into agriculture development projects in relation to management of water catchment, forests and wildlife conservation. Additionally, roles and functions at different levels should be enhanced through decentralization of decision making by adopting three water resources management levels (including National Basin and Sub-basin/catchment levels) and setting up appropriate institutions clearly defining the role of each and how they relate to each other.

Kenya's water towers are generally considered as indigenous forest; however, the buffer zones may be extended depending on the needs as may be deemed necessary for appropriate implementation of the management plan. Within the buffer zones, KWS and KFS work collaboratively with institutions mandated to prepare physical development plans and participate in activities to support the communities. Finally The Kenya Forest Service should embrace participatory forest management as the mechanism of involvement of communities in forest management and preparing all management plans to ensure that the stakeholders accept the plan and participate actively in its implementation in the spirit of water catchment protection.

In checking further catchment degradation there is need to initiate and adopt the pluralistic customary and stakeholder views on resource management. In this case emphasis will be placed on educating the communities living along River Njoro who belong to different cultural backgrounds to appreciate the need for forest and subsequently catchment conservation. The different communities have different histories of settlement in the watershed. Starting at the top, in the upper indigenous forested zone are the Ogiek people, who are traditionally hunters and gatherers but have recently begun to settle the land adjacent to forests. Newly arrived and settled Kalenjin groups are mixing with Ogiek in the upper two zones. In the lower zone and before the river enter into the lake are mixed groups of people from different parts of Kenya, some living in urban centers and owning farms along the River Njoro. Each of these groups has diverse livelihood interests and activities and a different historical attachment to the land. Some are more interested in pastoralism, while others are a mixture of agriculture and livestock, while others have predominantly urban lifestyles. In all these cases, either directly or indirectly, they depend on the natural resource base, in particular, on water and riparian

resources in the public domain in the River Njoro watershed. Each of these stakeholders applies their own cultural values and experiences in the way they view River Njoro water and riparian resources and therefore need to diversify education on conservation and management of the Njoro water catchment.

### **Conclusions**

The 2003-2007 economic recovery strategy paper recognizes that Kenya faces serious environmental challenges due to previous forest mismanagement, and that deforestation is a key symptom of environmental damage. Kenya's civil society now also has a strong voice, willing to challenge poor environmental governance. The 2003 –2005 forest cover change analysis findings reveal that Mau forests continue to be destroyed at an alarming rate. About 9,813 hectares (9,295.72 hectares indigenous forest and 517.87 hectares plantation forests) were cleared, compared to 7,084.24 hectares (most of it plantation) between 2000 and 2003. The Mau Complex forests therefore clearly justify an ecosystem that requires urgent attention to curb rampant destruction of indigenous forest (Kundu *et al.*, 2004). The continued destruction of the Mau forests threatens the livelihood of many people. Most of the loss is attributed to continued irrational settlement of people within Mau in areas including those which are prone to erosion and unsuitable for agriculture.

The water towers west of the Rift Valley have started to show remarkable recovery as evidenced by stable forest covers, levels of river flow and the surging of Rift Valley lakes. The continued destruction of Kenya's water towers is spelling doom to the present and future generations and in essence therefore threatening the livelihood nation. The water towers in Kenya have to be accorded an ornamental attachment. Therefore the continued and irrational settlement of people within the water catchment areas has to be addressed with urgency by all and sundry. Land use and development activities in the water towers and catchments in Kenya should put into consideration the ecological integrity and environmental consequences therefore there is need for Environmental Impact Assessment for all new developments including settlement, farming, industries and urban development in the water towers in Kenya.

In the River Sosiani catchment, there were several human activities that were identified; including forestry, crop and livestock rearing, Settlement and

urbanization (Ontumbi and Sang, 2017 and Aura *et al.* (2011).

Conclusively in the words of Prof Wangari Maathai, “I have been trying to convince others in government and in the community that we need to stop cutting or cultivating crops in our indigenous forests. When the forests are cleared, rivers and streams dry up, biodiversity is lost, and rainfall becomes erratic. This threatens farmers’ livelihoods and has negative impacts on other species as habitats and the water

catchment areas are lost.” Further Prof. Maathai asserted, “I keep telling people, let us not cut trees irresponsibly...especially the forested mountains. Because if you destroy the forests, the rivers will stop flowing and the rains will become irregular and the crops will fail and you will die of hunger and starvation. Now the problem is, people don't make those linkages” (The Green Belt Movement Watershed Workshop).

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